

## GENERAL NOTES

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### A STUDY OF HYBRIDIZATION BETWEEN *COLIAS ERATE* AND *C. EURYTHEME* (PIERIDAE)

**Additional key words:** sex ratio, variation, phylogenetic relationships.

Hybridization among some species of *Colias* is common in nature, and many species of the genus can be hybridized under laboratory conditions (e.g., Gerould 1943, Hovanitz 1949, 1955, Remington, 1954, Ae 1959). In 1992, I had the opportunity to conduct hybridization experiments between *Colias erate* Esper and *Colias eurytheme* Boisduval. The source of the *C. eurytheme* stock was Sweet Briar College in Virginia, USA; the source of *C. erate* was Aichi Prefecture, Japan. Hybridization studies were conducted in the rearing room of the Biological Laboratory, Nanzan University, at 25°C and using fluorescent lights to create an 18 hr:6 hr light-dark regime.

Three white *C. erate* females were reared from eggs laid by a field collected, white female; the females emerged 13 May 1992. The females were placed in a screen cage (ca. 25 × 25 cm) with several field collected males of *C. eurytheme*. One of the females mated with a male almost immediately, and copulation lasted more than an hour. This female laid about 100 eggs on white clover, *Trifolium repens* L. (Fabaceae), all of which hatched. I reared the larvae of these F1 hybrids on white clover and alfalfa, *Medicago sativa* L. (Fabaceae) in the rearing room. From 10 to 23 June 1992, 25 males and 25 females of F1 adults were obtained (Fig. 1, Table 1). Concurrently, a brood of *C. eurytheme* males and females was reared from eggs from the Virginia stock on white clover and alfalfa.

Using the F1 adults, additional field collected *C. erate*, and the progeny of the Virginia stock, the following pairings were achieved: (a) three matings between F1 siblings; (b) two matings between *C. eurytheme* females and F1 males; (c) one mating between an F1 female and a *C. eurytheme* male; (d) one mating between a *C. erate* female and an F1 male; (e) one mating between an F1 female and a *C. erate* male (Table 1).

Among the mated females, one of the F1 hybrid sibling matings laid one egg; one F1 female paired with a *C. erate* male laid 7 eggs, and one *C. eurytheme* female paired with an F1 hybrid male laid 21 eggs. None of these eggs turned red, as is typical for developing *Colias* eggs, and all were presumed to be infertile. Three *C. eurytheme* females reared from eggs laid by the Virginia field collected females paired with field collected *C. erate*. One laid about 100 eggs and another laid about 40 eggs, none of which were fertile.

*Colias erate* has a yellow ground color and a sex-limited female white form. Japanese *C. erate* males and females have irregular yellow blotches in the marginal black band (Fig. 1), similar to female *C. eurytheme*. *Colias eurytheme* has an orange ground color and a sex-limited white form. In contrast to *C. erate*, the marginal band in male *C. eurytheme* is uniformly black, without yellow blotches (Fig. 1). The F1 males generally were intermediate in ground color (Fig. 1), however, yellow blotching in the marginal band was variable from almost absent to blotching as in *C. erate* (Fig. 2). White females of *C. erate* and *C. eurytheme* are extremely similar, as were the F1 white females (Fig. 3). Eggs, larvae, and pupae of *C. erate* and *C. eurytheme* are nearly identical, as were those of the F1 hybrids to the parental stock.

In my previous hybridization experiments, F1 hybrid males between *C. eurytheme* and *C. interior* Scudder were fertile, although the F1 sex ratio was predominantly males (26 males:1 female). The sex ratio of F1 hybrids between *C. erate* females and *C. eurytheme* males was 1:1, but they were infertile. Two *C. eurytheme* females that paired with *C. erate* males laid only infertile eggs. Although additional experiments are necessary to corroborate these results, it appears that *C. erate* from Japan and *C. eurytheme* from the United States are not closely related. There are many species of *Colias* in the world, many of which closely resemble each other morphologically. Hybridization studies such as this may be useful in identifying phylogenetic relationships among these morphologically similar species.

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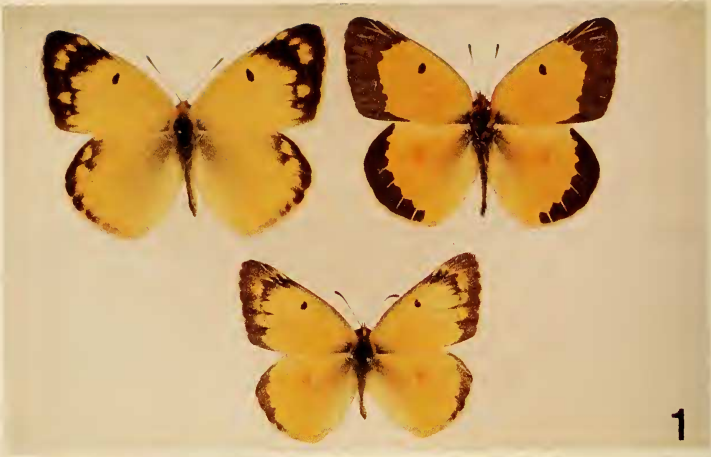


TABLE 1. Results of hybridization attempts between *Colias erate* and *Colias eurytheme*. EU = *C. eurytheme*; Coe, ER = *C. erate*.

Female parent	Male parent	Kind of mating	Eggs laid	Eggs % fert.	F1 adults male/female	
Coe-1-7	Cou-6	Eu × Er	100	100	25	25
Coe-1-7-23	Coe-1-7-2	F1 × F1	1	0	—	—
Coe-1-7-25	Coe-1-7-8	F1 × F1	—	—	—	—
Coe-1-7-35	Coe-1-7-16	F1 × F1	—	—	—	—
Coe-1-7-46	Coe-12	F1 × Er	7	0	—	—
Coe-1-7-48	Cou-1-8	F1 × Eu	—	—	—	—
Coe-8-22	Coe-1-7-15	Er × F1	—	—	—	—
Cou-3-26	Coe-1-7-3	Eu × F1	21	0	—	—
Cou-3-44	Coe-1-7-31	Eu × F1	—	—	—	—
Cou-4-13	Coe-16	Eu × Er	—	—	—	—
Cou-4-14	Coe-17	Eu × Er	40	—	—	—
Cou-4-40-1	Coe-18	Eu × Er	100	—	—	—

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SHIGERU A. AE, *Biological Laboratory, Nanzan University, 18 Yamazatocho, Showaku, Nagoya, 466, Japan.*

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FIGS. 1–3. Adult *Colias erate*, *C. eurytheme* and their hybrids. **1**, *C. erate* female (upper left), *C. eurytheme* male (upper right), F1 hybrid (below). **2**, variation among F1 hybrids of *C. erate* × *C. eurytheme*. **3**, female white forms: *C. erate* (upper left), *C. eurytheme* (upper right), F1 hybrid (below).